Oviposition habitat and feeding behaviour of the dingy skipper (*Erynnis tages* (Linnaeus, 1758), in Schleswig-Holstein (North Germany) (Hepseriidae)

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Abstract. The habitat requirements of the dingy skipper (*Erynnis tages* (L., 1758), Hesperiidae), especially for oviposition, were unknown in Schleswig-Holstein, North Germany. In order to gain information on its environmental requirements, egg-laying females were observed in early June, 2006, at one location close to the town of Schleswig. Altogether, 62 egg depositions were recorded and different parameters were measured. The only host plants in this region are small, separated growing, non-flowering plants of *Lotus corniculatus* (L., 1753, Fabaceae) which were exposed to the sun. These observations point toward a narrow microclimatic preference of the butterfly in this area. Additional visiting of flowers by the imagines was observed. *Erynnis tages* seems to prefer yellow-flowering plants.

Zusammenfassung. Die Habitatansprüche des Leguminosen-Dickkopffalters (*Erynnis tages*) sind bisher wenig untersucht worden. Deshalb wurden Anfang Juni 2006 Weibchen bei der Eiablage in einer ehemaligen Kiesgrube nahe Schleswig in Norddeutschland beobachtet und unterschiedliche Parameter an den Eiablagestellen aufgenommen. Insgesamt konnten 62 Eiablagen beobachtet werden. Es wurden ausschließlich kleine, einzeln stehende, nicht blühende Pflanzen von *Lotus corniculatus* belegt, die gleichzeitig stark besonnt waren. Dies deutet auf eine enge mikroklimatische Einnischung des Falters in diesem Gebiet hin. Zusätzlich wurden die von den Imagines aufgesuchten Blütenpflanzen dokumentiert. *Erynnis tages* scheint gelb-blühende Pflanzen zu bevorzugen.

Introduction

In Schleswig-Holstein, North Germany, the dingy skipper (*Erynnis tages* (Linnaeus, 1758) is threatened with extinction. Formerly widespread in different types of nutrient-poor grasslands, it is now found in stable populations at only three sites (Kolligs 2003). *Erynnis tages* is also listed as highly endangered in adjacent Denmark (Stolze 2005).
In Central Germany oviposition and adult habitats in semi-dry calcareous grasslands have been analysed by Fartmann (2004). But for successful conservation and recolonisation of this species in Schleswig-Holstein, a detailed knowledge of the local egg-laying and larval habitat is essential, such as Asher et al. (2001) published for the conservation action plans in Great Britain. In contrast Fartmann & Hermann (2006) have shown that the knowledge needed for the conservation and recolonisation of most Central European butterfly species, including *E. tages*, is still insufficient.
Therefore, this paper uncovers the habitat requirements of *E. tages* in a part of Northern Germany, including the oviposition microhabitats as well as the feeding behaviour of the butterfly.

Material and methods

Study Area. The study was carried out near the city of Idstedt, close to the city of Schleswig (Schleswig-Holstein, North Germany) (Fig. 1a). The study area was for-

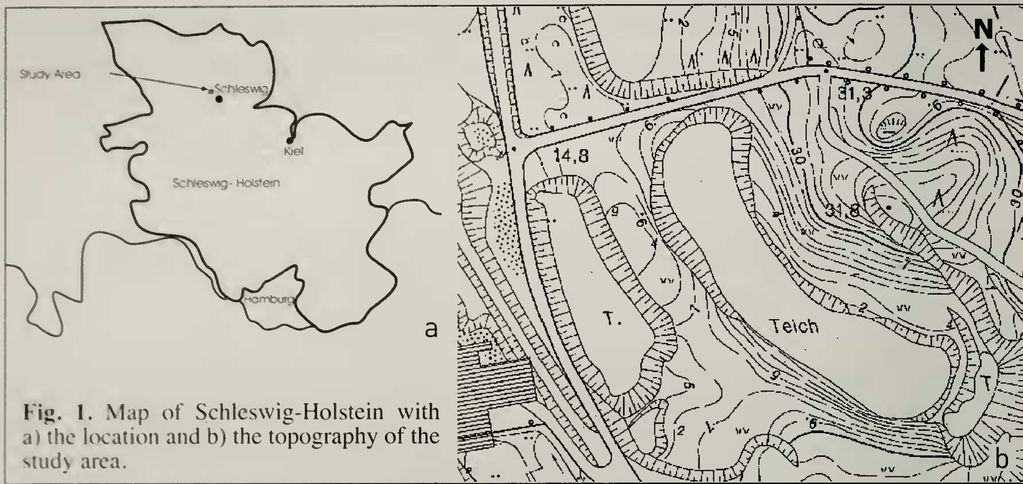


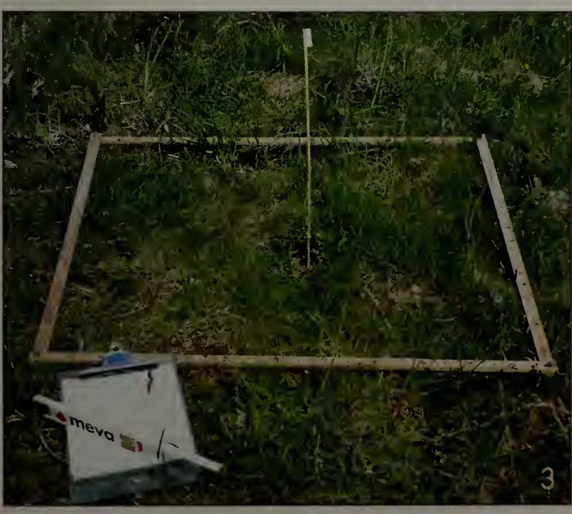
Fig. 1. Map of Schleswig-Holstein with a) the location and b) the topography of the study area.

merly used as a gravel pit. The butterfly had a scattered distribution on the site, reaching highest densities between two ponds (Fig. 1b). The study area was characterised by a nutrient-poor (oligotrophic) grassland community (e.g. *Agrostis capillaris* (L., 1753, Poaceae), *Anthyllis vulneraria* (L., 1753, Fabaceae), *Hieracium pilosella* (L., 1753, Asteraceae) and *Lotus corniculatus*) with shrubs (Fig. 2). The open parts were exposed to the sun, where different young trees were coming up (e.g. *Acer pseudoplatanus* (L., 1753, Aceraceae), *Betula pendula* (Roth, 1788, Corylaceae), *Crataegus monogyna* (Jacq., 1775, Rosaceae), *Quercus robur* (L., 1753, Fagaceae), and *Larix decidua* (Mill., 1768, Pinaceae).

Observation of oviposition. These observations were carried out from June 2 to June 8, 2006. The egg-laying analysis started with the pursuit of females, with care taken not to disturb them. When egg-laying was observed, the site was marked with a post. Following egg deposition, the female was pursued further, if possible. The observation was stopped after five minutes if the female did not lay additional eggs. Sample plots were established with the host plant in the center of the area. Each sample plot included one square meter around the egg-laying site (Fig. 3). The following environmental parameters were measured: 1. Growth form of the plant (single-shooted, oligo-shooted, young side shoot, extensive stand); 2. Plant height; 3. Oviposition height; 4. Mean vegetation height (three measurements, randomly); 5. Vegetation coverage (estimated, in 5% units), 6. Mean litter layer height (three measurements immediately at the covered plant).

Feeding behaviour of the adults. The feeding behaviour of *Erynnis tages* was observed during monitoring of the females. The plant species and the quantity of feeding observations were recorded.

Statistics. The statistical analysis was carried out with STATISTICA (Statsoft 1998). Data were tested on normal distribution with Kolmogorov-Smirnov-test. No normally distributed data were found so a Spearmen-rank correlation was calculated for all measured parameters.



Figs 2–3. Study area. **2.** Habitat between the two lakes; view from the south. **3.** Marked egg-laying plant in the centre of the sample plot.

Results

Feeding observations. The butterflies were observed visiting flowers primarily in the morning and after oviposition. During phases without sun, the butterflies rested on the vegetation. Yellow-flowered plants were the most frequented (515 of 574; 89.7%). Feeding was observed less often on blue-violet flowers (43 of 574; 7.5%). Red and white flowers as well as plants with small flowers were rarely visited (16 of 574; 2.8%) (Fig. 4). *Hieracium pilosella* and *Trifolium medium* (L., 1759, Fabaceae) were the most abundant flowering plant species at the time of our observations. However, *Trifolium medium* was clearly less used than *Hieracium pilosella*. *Lotus corniculatus* was often visited too, though it just started flowering during our field work.

Oviposition. In total, 62 egg ovipositions were observed. The eggs were placed exclusively on *Lotus corniculatus*. Only one egg per plant was laid although once two eggs were found on one plant. Fifty-three of the 62 eggs deposited (85%) were placed on the costa of the upper surface (Fig. 5), eight eggs (12.9%) on the inferior leaf surface, and one egg (1.6%) on the stalk. There were no flowers developed on any of the host plants at that time.

Most of the occupied plants were single-shooted (62.9%) or oligo-shooted young plants (20.9%). In six cases (9.7%), the eggs were laid on a side shoot of a young plant; in four cases (6.5%), the eggs were laid in a *Lotus corniculatus* stand (Fig. 6).

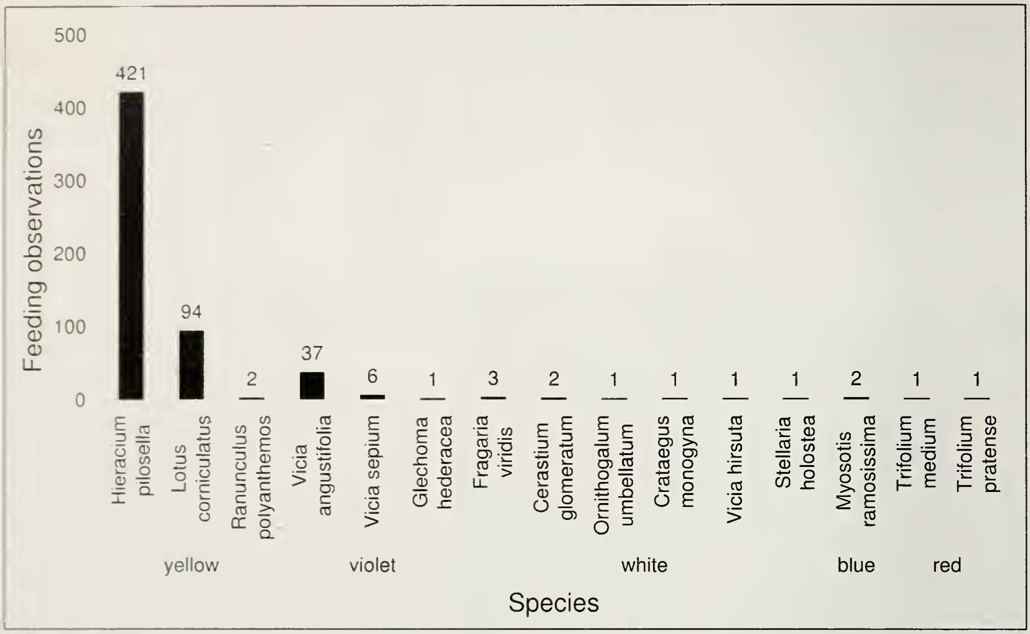


Fig. 4. Number of feeding observations during field work; n = 574.

Fig. 5. Shoots of Lotus corniculatus with eggs of *Erynnis tages* on the costa.

Most of the eggs (80.7%) were placed on small plants up to 9 cm height (Fig. 7). The highest number of eggs (45.2%) was found on plants that were 3 to 6 cm high. Egg placement on a plant that was more than 18 cm high was observed only once though extensive stands of *Lotus corniculatus* were the most frequent growth form (>80%)

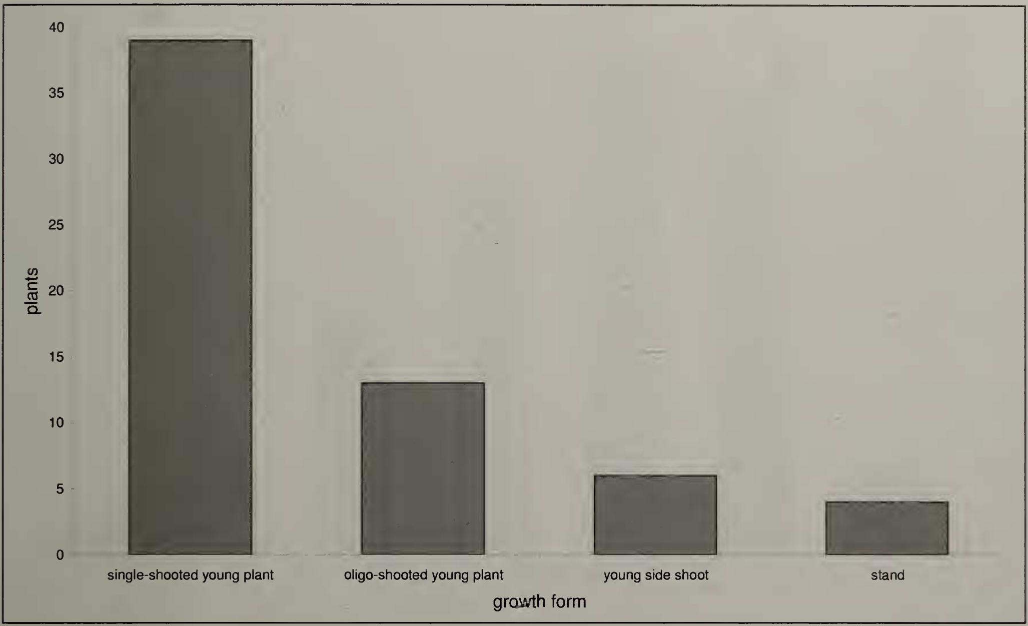


Fig. 6. Number of occupied *Lotus corniculatus* depending on growth form; n = 62.

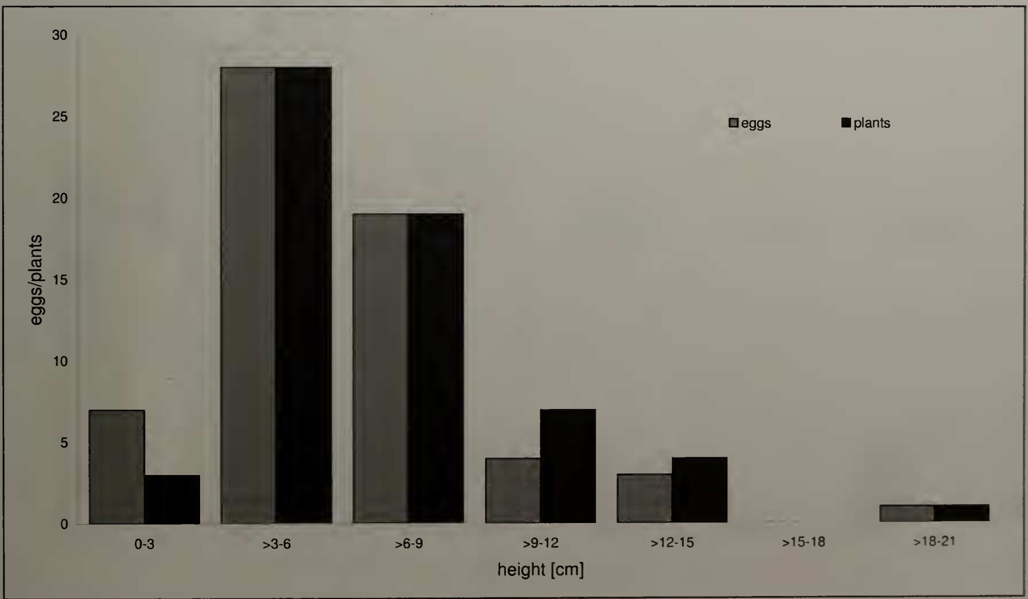


Fig. 7. Height [cm] of egg-laying of *Erynnis tages* and of occupied *Lotus corniculatus*; n = 62.

in the habitat. Most of the eggs laid (45.2%) were found 3 to 6 cm above ground. Above 6 cm, the number of eggs deposited decreased with an increase in the height of the plants. Egg depositions were only rarely observed at heights of more than 9 cm and less than 3 cm.

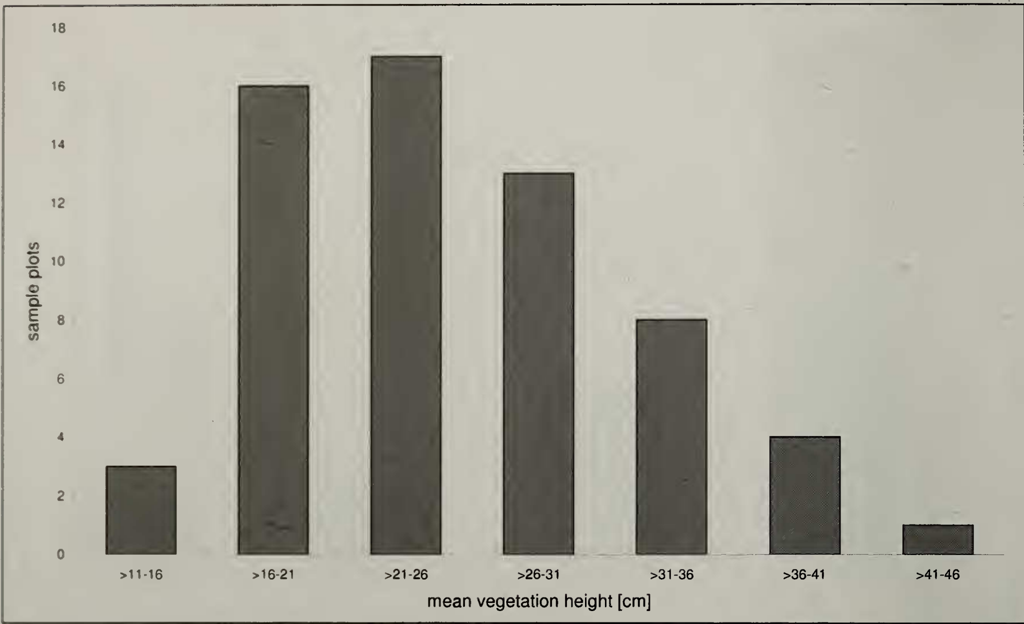


Fig. 8. Mean vegetation height [cm] one square meter around the occupied plants; n = 62.

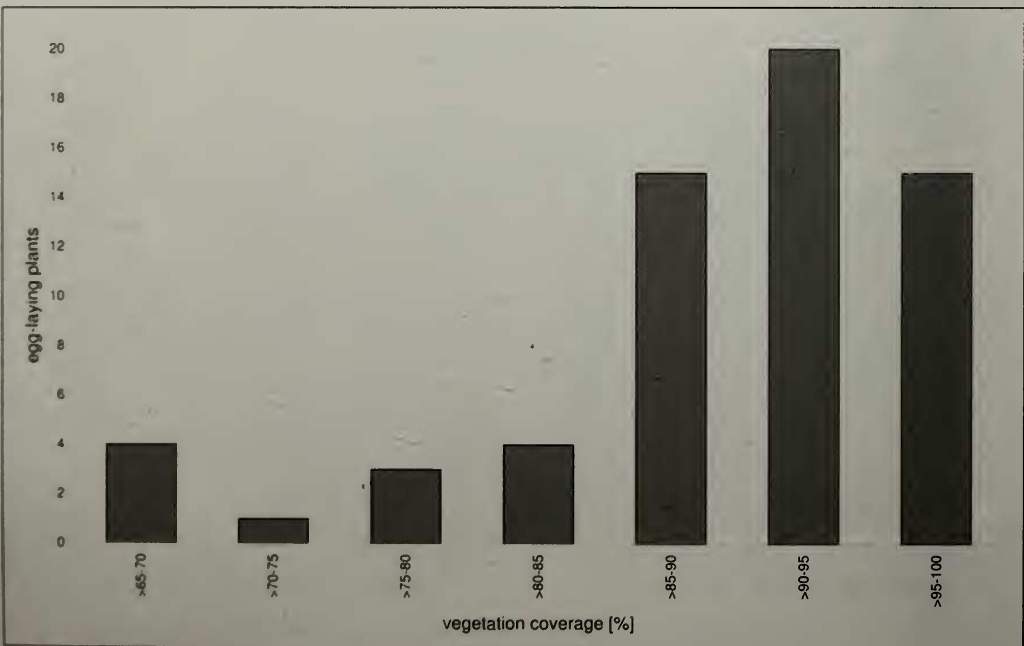


Fig. 9. Vegetation coverage [%] in the sample plots; n = 62.

Most of the occupied plants were located in plots with a mean vegetation height of >16 to 31 cm (74.2%). Below and above these values, ovipositions of *Erynnis tages* were observed in a wide spectrum of vegetation heights ranging between 11 and 42 cm

Tab. 1. Minimum (MIN), maximum (MAX), mean value (MV) and standard deviation (SD) for the examined parameters, n = 62.

	MIN	MAX	MV	SD
Plant height [cm]	2	20	6.8	± 3.3
Height of egg-laying [cm]	1.4	19.4	6.1	± 3.3
mean vegetation height [cm]	11.7	42	25.2	± 6.9
vegetation coverage [%]	70	100	91.7	± 8.1
mean litter layer height [cm]	0	6	1.4	± 1.4
Height of egg-laying in % of plant height	55.4	97.4	88.2	± 5.6

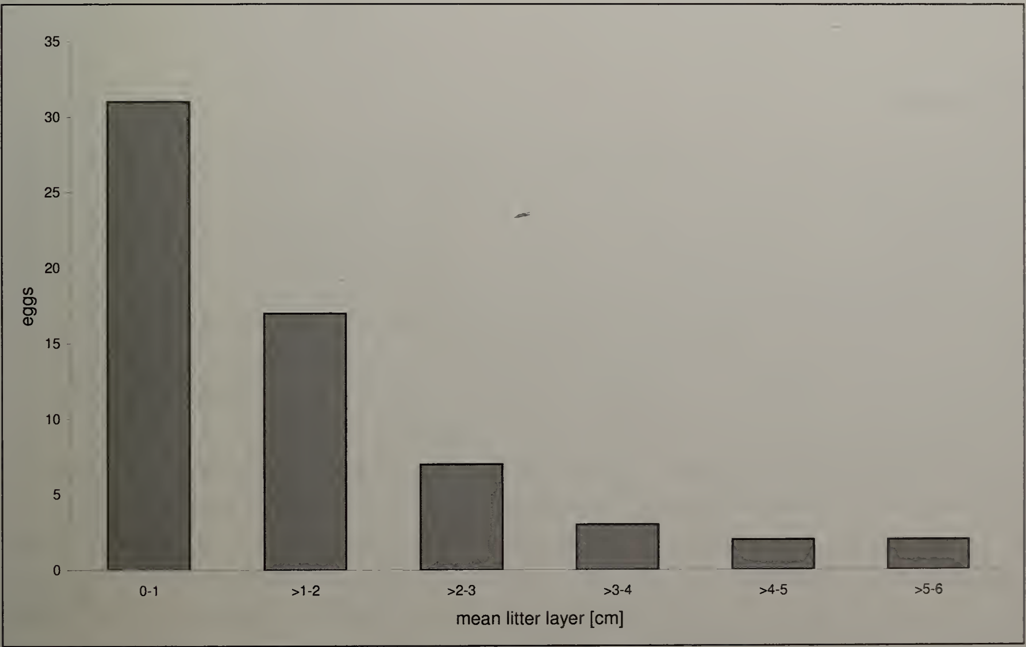


Fig. 10. Mean litter layer [cm] immediately under the occupied plant; n = 62.

(Fig. 8). The mean vegetation of all egg-laying sites was dominated by few grasses per square meter, resulting in a loose vegetation structure 5 cm above the ground.
The vegetation coverage in the examined plots was more than 65% in all areas. Most of the egg depositions (32.3%) were observed in sample plots with coverage between 90 and 95%. Overall, 80.7% of the eggs were placed in plots with more than 85% vegetation coverage (Fig. 9).
The litter layer was below 1.5 cm around a predominant number of the egg-occupied plants (71%). The number of egg depositions observed decreased with an increase in litter layer. The highest litter layer (6 cm) was observed only at one plant on which two eggs had been laid (Fig. 10).
For all parameters, the values for the minima and maxima show large deviations (Tab. 1).

Statistics. All recorded parameters were tested against the dependent variables "height of egg deposition" and "plant height" for the correlation analysis (Tab. 2). Significant linear correlations were found between plant height and mean litter layer, mean vegetation height and vegetation coverage as well as egg-laying height against plant height, mean litter layer, mean vegetation height, and vegetation coverage.
The height of egg deposition was positively correlated to plant height, but also with vegetation coverage, mean litter layer height, and mean vegetation height (Tab. 2). The height of the plant was also positively correlated with these four parameters (Tab. 2).
A positive correlation was also found between the height of egg deposition and the percentage of the used plant height. Most eggs were placed on the top 20% of the plant (Fig. 11).

Discussion

Visited flowers. The observation of flowers visited as nectar sources by *Erynnis tages* provided information on habitat requirements other than the larval food plant. Although *Lotus corniculatus* was the only plant observed for egg-laying, its importance as a nectar source for the adults was small, though it just started flowering during the time of our observations. The most abundant flowering plant species at that time were *Trifolium medium* and *Hieracium pilosella*. However, the most frequented flowering plant during this study was *Hieracium pilosella*. Whether this observation indicates a real preference for this plant species in general or just a reaction to the current flower offer (number in the study area during time of observation) cannot be answered at this time. Feeding observations on blue-violet flowers as well as red and white flowers may be assessed as an indication that *Erynnis tages* is able to use a wider spectrum of flowering plants. The affinity for Fabaceae, mentioned by Ebert & Rennwald (1993) could not be confirmed.
Egg-laying habitat. Our results show a clear preference for oviposition habitat in the investigated area. Because the observed *E. tages* females "showed" where they layed their eggs we can exclude that our results reflect our field search strategy or that alternative egg-laying structures were overlooked.
Plant height. The height of egg deposition was narrowly correlated with the height of the egg-laying plants. Small *Lotus corniculatus* plants were preferred as directly proven by our observations of the egg-laying females. The choice of small *Lotus corniculatus* plants for egg placement seems to point toward a narrow microclimatic preference because in the habitat such plants were only a minor resource. Extensive stands of *Lotus corniculatus* with plants more than 10 centimetres high dominated. The preference for small, isolated plants for oviposition contradicts the results of Gutiérrez et al. (1999) and Asher et al. (2001). They observed that females of *Erynnis tages* in Great Britain and Ireland chose large plants in hollows and sheltered situations as egg-laying sites. Fartmann (2004) found preferred egg-laying habitats of *Erynnis tages* in semi-dry and hot calcareous grasslands with short vegetation, where eggs were placed at a mean height of 7 cm and with a mean of 15% bare soil around the food

Tab. 2. Results of Spearman-rang-correlation (rs); n = 62; * = p < 0.05, ** = p < 0.01, *** = p < 0.001

	oviposition height	plant height
mean vegetation height [cm]	0.31*	0.30*
vegetation coverage [%]	0.28*	0.32*
litter layer height [%]	0.41**	0.38**
plant height [cm]	0.97**	-

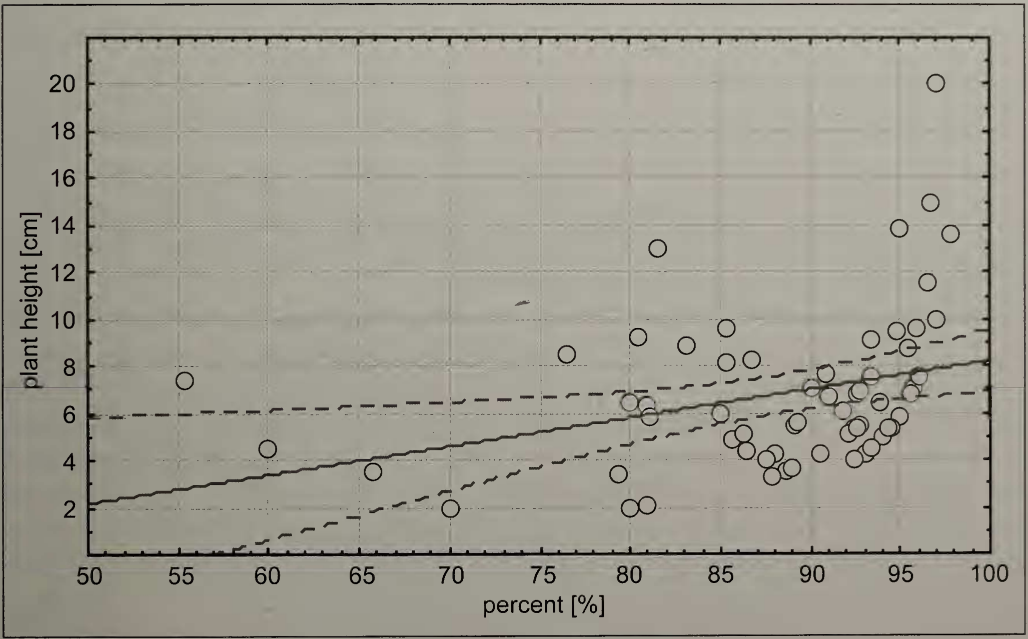


Fig. 11. Regression analysis of egg-laying height in percentage of the occupied plant versus plant height [cm]; r=0.32; p=0.01; y=-3.87 + 0.12*x.

plant. All studies indicate local accommodations on different habitats in order to find warm microclimatic conditions for oviposition. Therefore climatic differences between studied regions could be the reason for the use of varying habitat structures over the distribution range of *Erynnis tages*.

Mean vegetation height. A correlation between egg deposition and the mean vegetation height is shown. The eggs were mainly placed at sites with vegetation between 16 and 31 cm in height and dominated mostly by grasses. In all sample plots the vegetation structure was loose and dominated by single plants only. The advantage of these conditions is the combination of wind sheltering and good insolation of the eggs. Second, the females of *Erynnis tages* are able to fly low through the vegetation in search of oviposition plants (personal observation). No females have been observed flying in areas with high and dense vegetation.

Vegetation covering. Most eggs were deposited on plants surrounded by more than 80% vegetation coverage, mostly 100% coverage. Fartmann (2004) found most eggs in semi-dry grasslands on sites with varying percentages of bare ground around the food plant, preferably with 15% bare ground. In contrast, Gutiérrez et al. (1999) found that most eggs were laid "on large plants growing in hollows with intermediate cover of bare ground […]".

This difference in habitat selection of the English population could be interpreted as local accommodation for the preferred warm microclimate as well. It is also known that bare ground is used by the imagos for warming up and for water intake on wet soil (Ebert & Rennwald 1993). It is likely that there must be open soil in the habitat in general to allow these activities.

Mean litter layer. The egg-laying height was positively correlated to the mean litter layer height surrounding the egg-laying plant. A microclimatic influence of the litter layer on the choice of egg-laying sites seems possible. As Fartmann & Hermann (2006) pointed out, species with eggs susceptible to drought depend on habitats with higher humidity, mostly in combination with warm microclimatic conditions. We have observed that most eggs of *E. tages* at our study site were placed on plants surrounded by a thin litter layer. Fartmann (2004) found the eggs of *E. tages* in semidry calcareous grasslands mostly on plants with no litter layer underneath.

Conclusions. For *Hesperia comma* (L., 1758) (Hesperiidae), Hermann and Steiner (1997) showed that occurrence, frequency, and distribution are strongly limited by quality and expansion of suitable oviposition habitats. This depended on different parameters such as microclimate, host plants, and quantity and quality of food (Fartmann & Hermann 2006). In this investigation a microclimatic preference could be assumed from the shown positive correlation of plant height and oviposition height with the parameters measured. Unfortunately we did not map all plants of *Lotus corniculatus* in the sample plots. Generally not more than 5 to 10 single shoots per sample plot were found. In contrast, all areas were *Lotus corniculatus* stood in extensive stands were not used for oviposition. We interpret the shown range of used vegetation densities by *Erynnis tages* as a microclimatic preference which leads to increasing use of higher plants with increasing vegetation density and height in the observed possible spectrum. With increasing litter layer, mean vegetation height, or vegetation coverage the height of *Lotus corniculatus* plants used for oviposition increased also. In contrast, the height of egg deposition was independent of the height of the used plant and with only a few exceptions the top 20% of the plant was used.

For *Erynnis tages*, the microclimatic conditions seem to be an important parameter. Gutiérrez et al. (1999) suggested that "selection for warm micro-sites for egg-laying can be the result of temperature requirements for the early stages […]". Fartmann & Hermann (2006) assumed that exposition, slope, vegetation height, and vegetation coverage of the oviposition site as well as the height of egg deposition had a decisive influence on the microclimate and, consequently, on the chances of successful development from egg to imago.

In this study, the following oviposition requirements for *Erynnis tages* could be shown: (1) The egg-laying plants stood single; (2) The egg-laying plants were predominantly single stemmed, of stunted growth, and did not yet have developed flowers; (3) The eggs were placed on the leaf surface; (4) The eggs were laid on the top 20% of the plant; (5) The mean vegetation height ranged between 16 and 36 cm; and (6) The vegetation coverage was 85% or more. Occasional egg depositions on the inferior leaf surface or on the stalk may be connected to the plant's growth form. It may also depend on the way a female climbs along the host plant. Although extensive stands of *Lotus corniculatus* were most frequent at our study site, only small, single-stemmed young plants were chosen for oviposition by the observed females. The placement of just one egg per plant may be explained by a preference for young and small specimens of *Lotus corniculatus*; there were not enough food resources for more than one larva on one plant. Plants bearing eggs of their own species are often avoided in order to prevent competition between larvae (Fartmann & Hermann 2006).

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